Distribution and Diurnal Variation of Warm-Season Short-Duration Heavy Rainfall (SDHR) in Relation to the MCSs in China

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1 Data & Methods

- Hourly rainfall data are provided by the National Meteorological Information Center of China. The data cover the period April-September of 1991-2009, and were collected at 876 observation stations over mainland China.
- TBB dataset from GMS-5 and FY-2C satellites covers from June to August of 1996–2007 (excluding 2004).
- The climatology of SDHR is explored by calculating climatological distributions of hourly rainfall ≥ 10, 20, 30, 40, and 50 mm over China.
- MCSs are defined as grid cells with TBB ≤ −52° C at a horizontal resolution of 0.1° ×0.1° .

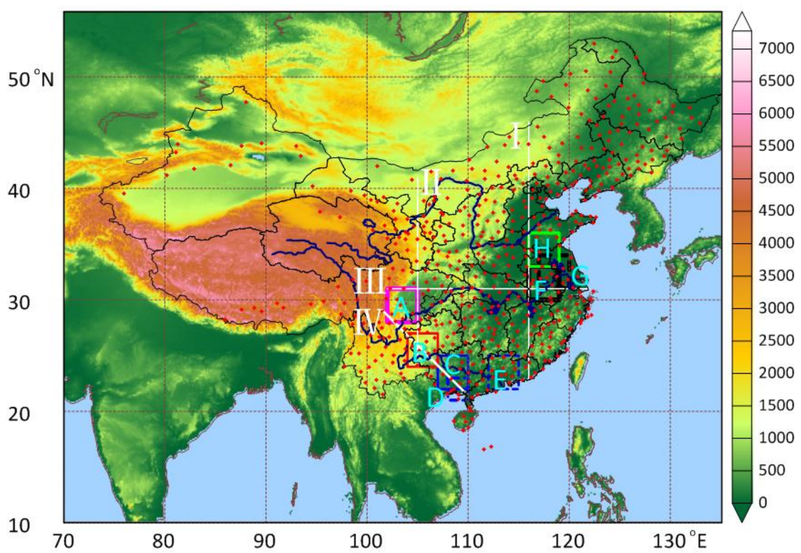

Fig.1 Orography and geography of China (shading), with selected meteorological observation stations (red dots) and analysis regions (white solid lines labeled I, II, III, and IV denote the positions of different cross sections; rectangles labeled A, B, C, D, E, F, G, and H indicate regions used to calculate diurnal cycles of SDHR and TBB≤–52° C; see text for details).

2 Spatial distributions

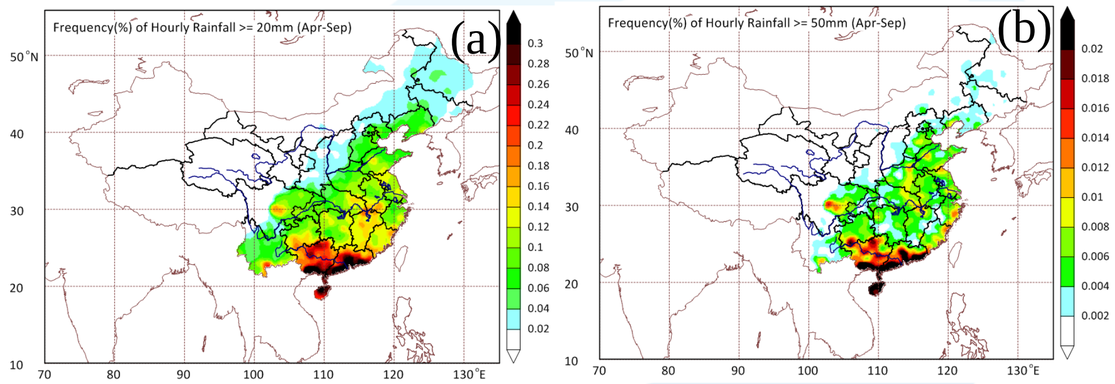

Fig.2 Frequencies of SDHR events (%) exceeding (a) 20 mm h^{-1} and (b) 50 mm h^{-1} during the warm season (April–September).

The spatial distribution of SDHR events exceeding 20 mm h^{-1} is very similar to the distribution of the annual mean number of heavy-rain days in China (Zhang and Lin, 1985; China Meteorological Administration, 2007). SDHR events generally occur more frequently in southern China than in northern China. They also occur more frequently in eastern China than in western China, and are more common over plains and valleys than over the adjacent plateaus and mountains. Seasonal rainfall over most of China is closely associated with the movement of the East Asian summer monsoon (Tao, 1980). SDHR events therefore occur more frequently in regions strongly affected by the summer monsoon than in regions where the influence of the summer monsoon is small.

The frequency of extreme SDHR (hourly rainfall ≥ 50mm) is very low throughout China (Fig. 2b).The maximum frequency is only 0.08%, which corresponds to only 8 h of extreme SDHR in every 10000 h (approximately 417 days). Extreme SDHR events occur most frequently over the coastal areas of Fujian and Zhejiang, central Henan, southern Hebei, and southwestern Liaoning provinces. The spatial distribution of extreme SDHR≥ 50 mm h^{-1} is very similar to the spatial distribution of heavy rain≥ 100 mm day^{-1} reported by Zhang and Lin (1985). Extreme SDHR activity (rain rates ≥ 50 mm h^{-1}) is much more scattered and heterogeneous than SDHR activity (rain rates ≥ 20 mm h^{-1}). This difference may be because extreme SDHR is mainly produced by extreme micro-scale weather systems, or it may be attributable to special terrain characteristics. Extreme SDHR is more common along the coastal areas of southeastern China than in inland areas because the coastal areas are more commonly affected by extreme weather systems associated with typhoons or tropical easterly waves.

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3 Diurnal variations

3.1Mean diurnal variations over China

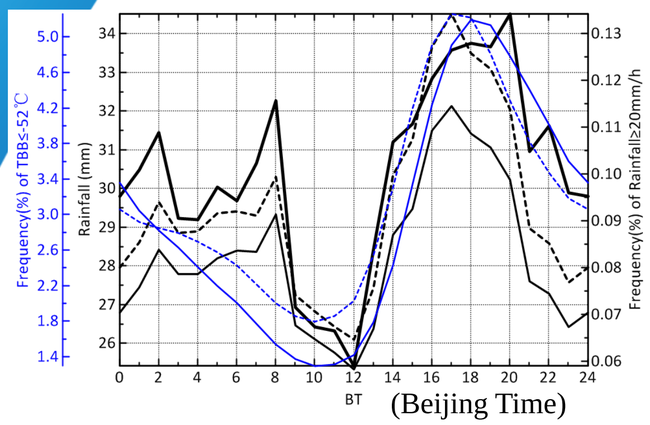

Fig.3 Diurnal variations in mean frequency and maximum hourly rainfall for SDHR events with rainfall ≥ 20 mm h^{-1} and brightness temperatures (TBB) less than –52° C. Diurnal variations in the mean frequencies are shown for SDHR averaged over all of China (thin black solid line), SDHR averaged over the active precipitation region (black thick dashed line), TBB ≤ –52° C averaged over all of China (blue solid line), and TBB ≤ –52° C averaged over the active precipitation region (blue dashed line). The thick black solid line shows the maximum hourly rainfall averaged over all of China. The blue *y*-axis indicates the frequency of TBB ≤ –52° C (unit: %), the black *y*-axis on the left indicates hourly rainfall (unit: mm), and the black y-axis on the right indicates SDHR frequency (unit: %).

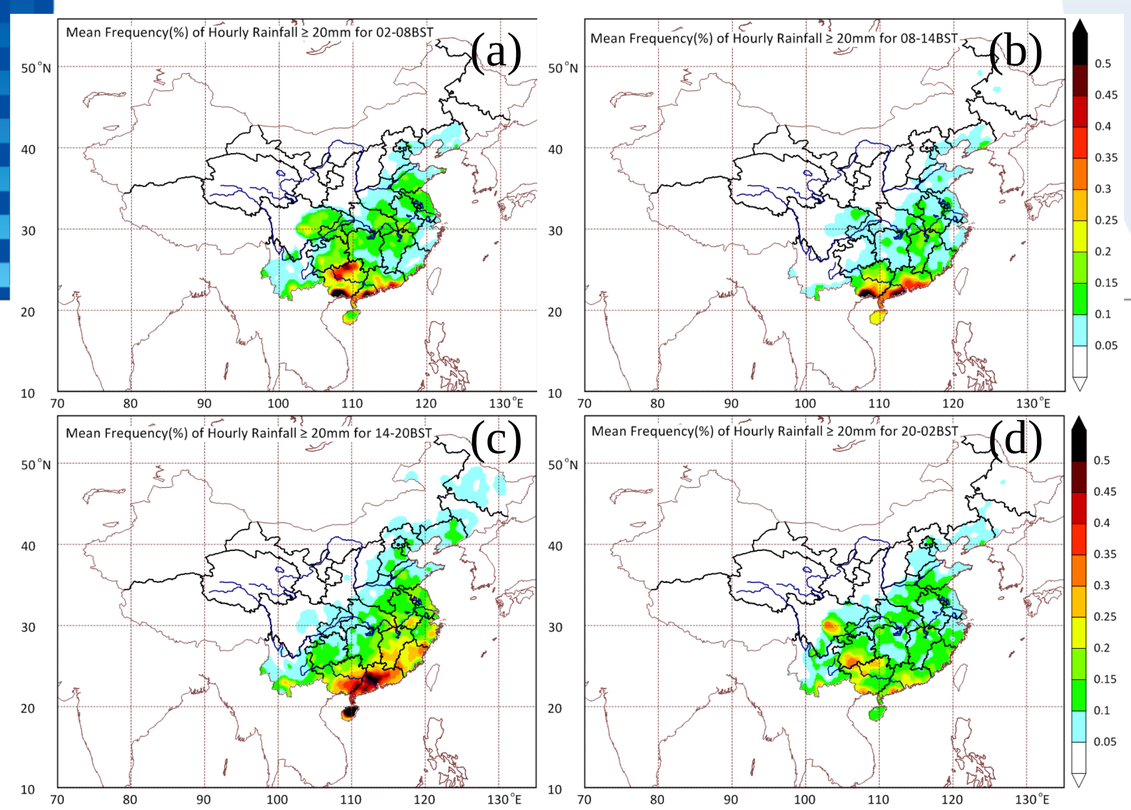

Fig.4 Diurnal variations of the frequency (unit: %) of SDHR with hourly rainfall ≥ 20 mm $h^{-1}$for (a) 0200–0800 BT, (b) 0800–1400 BT, (c) 1400–2000 BT, and (d) 2000–0200 BT.

3.2Diurnal variations over different regions

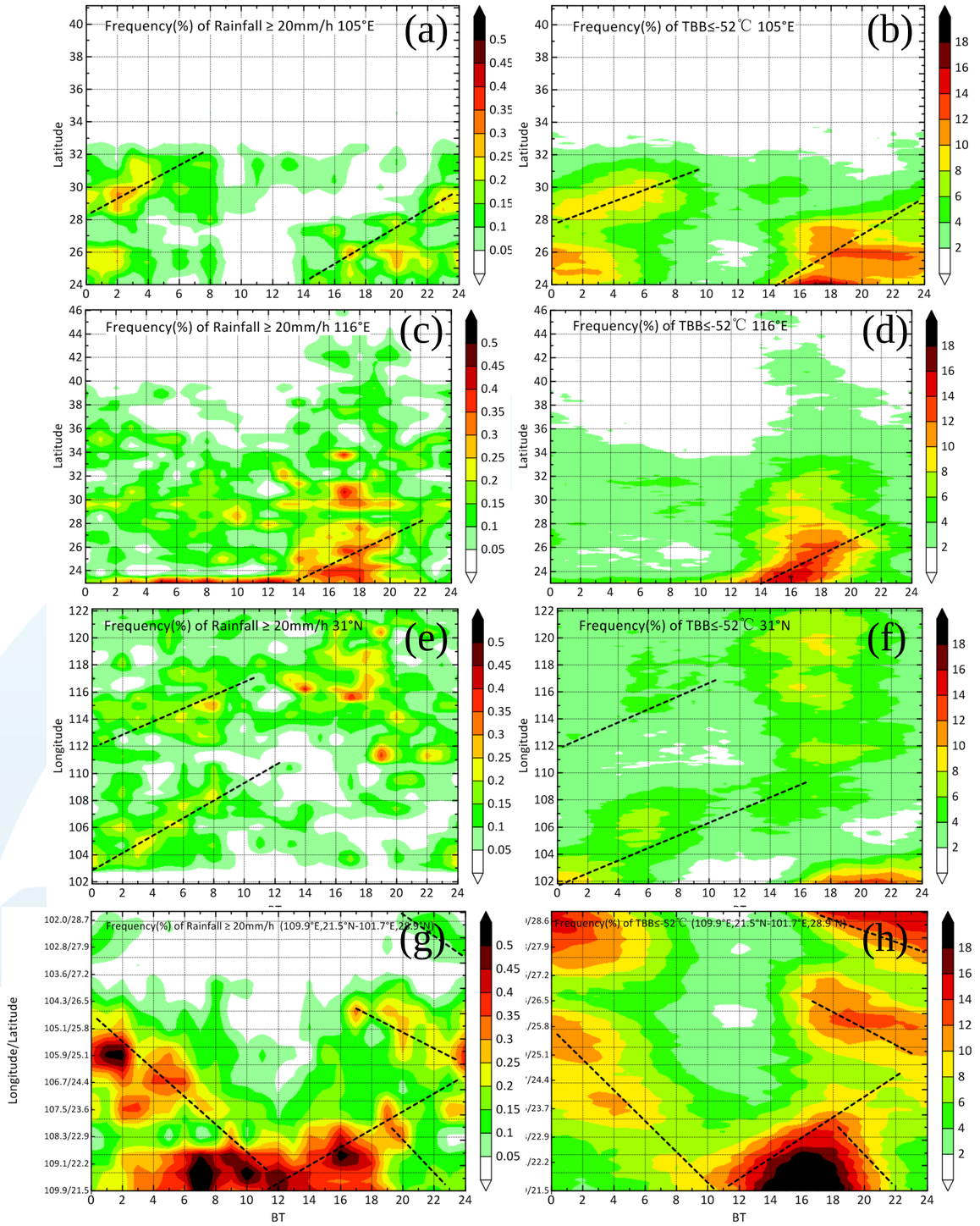

Fig.5 Temporal cross-sections of diurnal variations in the frequencies (unit: %) of SDHR (hourly rainfall ≥ 20 mm; left column) and MCSs (TBB ≤–52° C; right column) along (a, b) the 105° E meridian, (c, d) the 116° E meridian, (e, f) the 31° N parallel, and (g, h) the straight line (28.9° N, 101.7° E) –(21.5° N, 109.9° E). (The positions of the cross-sections are indicated by the white lines in Fig. 1)

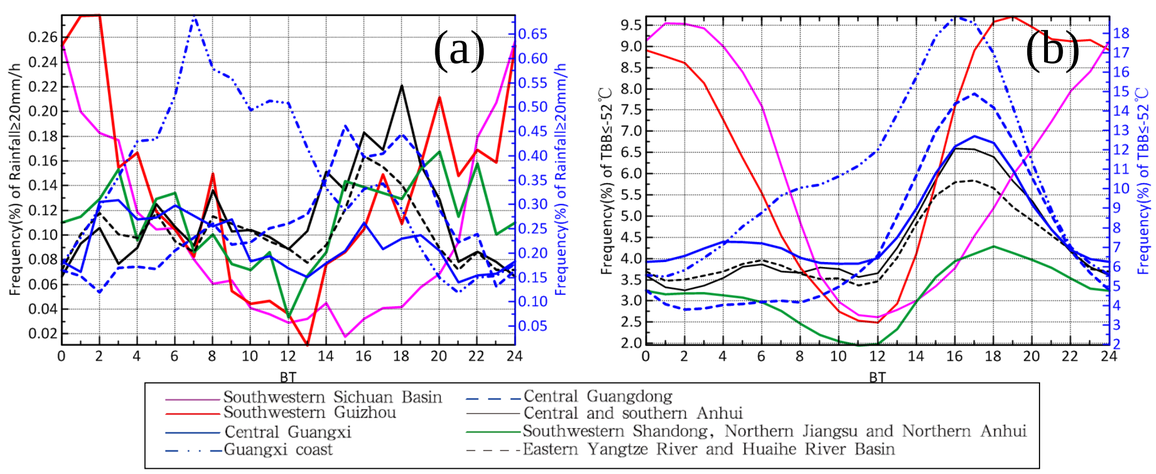

Fig. 6 Diurnal variations infrequencies (unit: %) of (a) SDHR (hourly rainfall ≥ 20 mm)and (b) MCSs (TBB ≤–52° C). The blue curves (for central Guangxi, the coastal area of Guangxi, and central Guangdong) use the blue (right) ordinate axes; the curves for other regions use the black (left) ordinate axes.